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Latest Estimate of Power Generation Costs by Power Source, and Cost-Benefit Analysis of Alternative Power Sources (Outline)

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- ◆ RITE estimated power generation costs by power source in Japan during FY2009-2010 before the Great East Japan Earthquake (estimate for the period 2005 to 2007 and future prospects). On the other hand, after the Great East Japan Earthquake and the Fukushima Daiichi nuclear plant accident, the Japanese government established the Cost Verification Committee under the Energy and Environment Council in autumn 2011 and estimated power generation costs by power source.
- ◆ In the light of subsequent changes in various situations, this report provides the latest estimate of power generation costs. Included in the changes in situations are the trend of increasing fossil fuel prices, the trend of increasing costs for improving the safety of nuclear power generation, and introduction of the Feed-in Tariff Scheme for Renewable Energy and the subsequent change in renewable energy costs. These factors were taken into consideration for this study.
- ◆ As compared to the estimate by the Cost Verification Committee, a more comprehensive and logical approach has been taken for this estimate of power generation costs by power source.

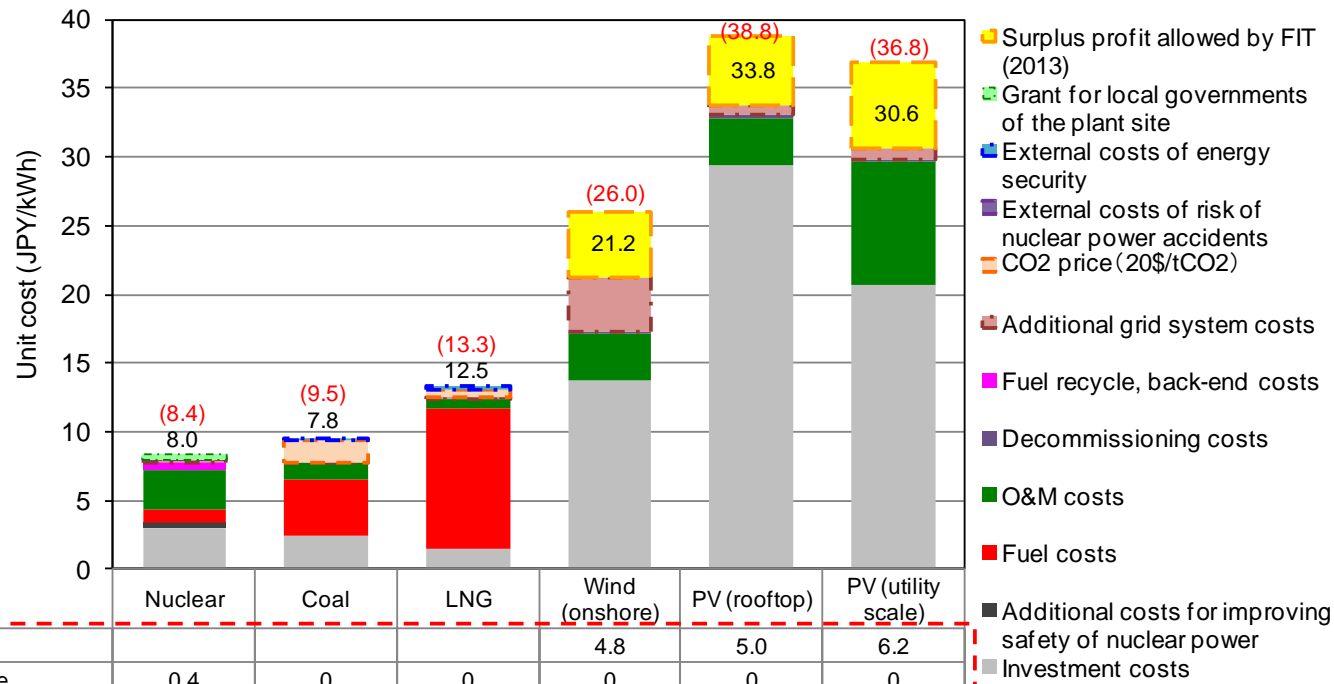
For the full report, see http://www.rite.or.jp/Japanese/lab0/sysken/about-global-warming/download-data/PowerGenerationCost_estimates_20141020.pdf

Using a mix of various power sources with their respective characteristics taken into consideration makes it possible to decrease power generation costs as a whole and keep a good balance among various factors, such as CO2 emission reduction and energy security improvement. It should be noted that, even if the power generation unit costs of some power sources are high, they can still be important components of power mix.

Estimation of Power Generation Costs by Power Source for 2013

Individual cost items are estimated with certain assumptions with different levels of confidence. Please see the full report to clarify the assumptions.

As compared to a cost of ¥8.4/kWh for nuclear power, the cost of wind power is ¥26.0/kWh (3.1 times that of nuclear power) and the cost of photovoltaic power is ¥36.8 to 38.8/kWh (4.4 to 4.6 times).



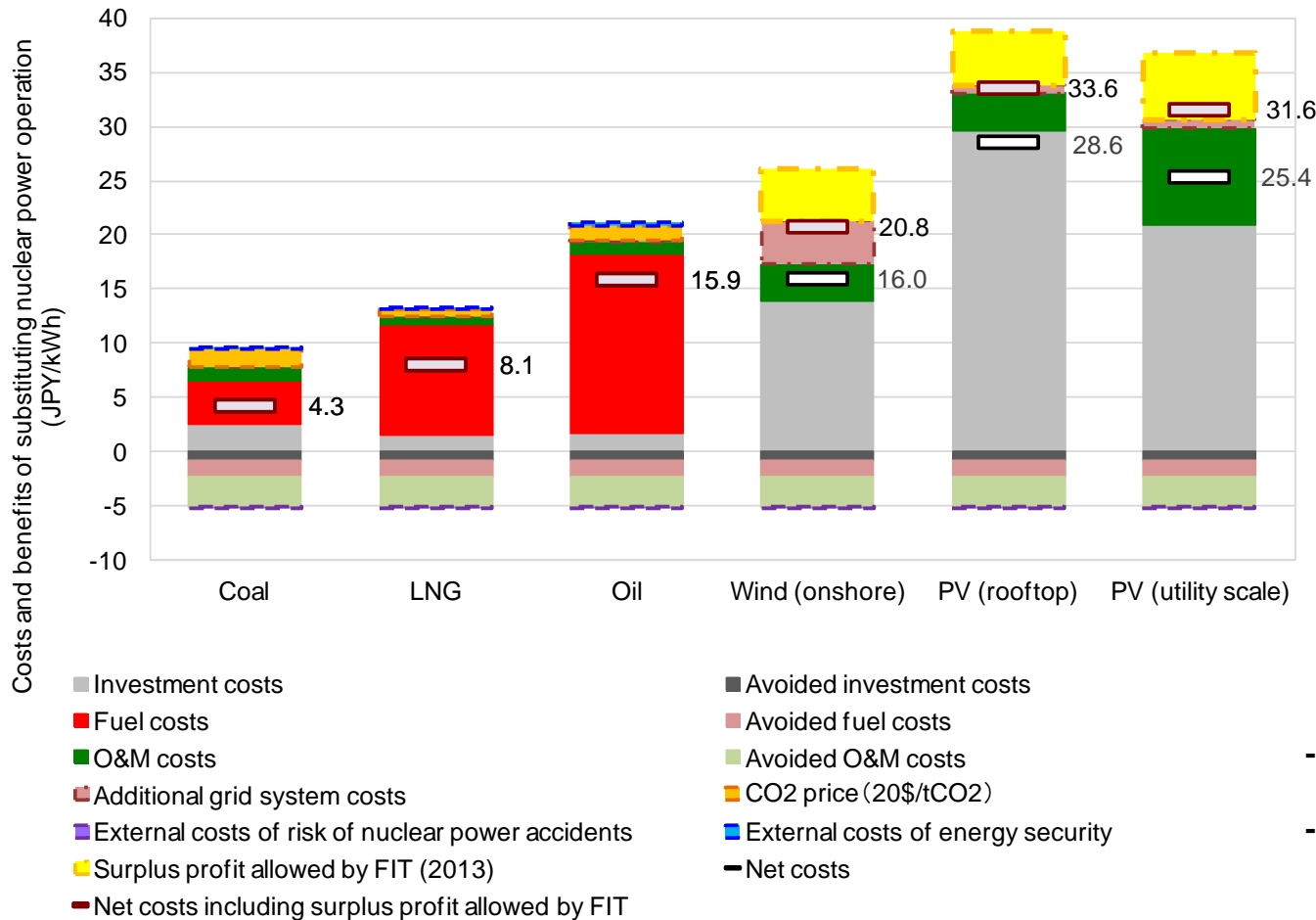
Surplus profit allowed by FIT (2013)				4.8	5.0	6.2
Grant for local governments of the plant site	0.4	0	0	0	0	0
External costs of energy security		0.09	0.19			
External costs of risk of nuclear power accidents	0.012					
CO2 price (20\$/tCO2)		1.6	0.6			
Additional grid system costs	0.25	0.1	0.1	4	0.8	0.8
Fuel recycle, back-end costs	0.5					
Decommissioning costs	0.05	0.01	0.01	0.1	0.2	0.2
O&M costs	2.85	1.18	0.68	3.4	3.4	9
Fuel costs	1	4.1	10.3	0	0	0
Additional costs for improving safety of nuclear power	0.42					
Investment costs	2.9	2.4	1.4	13.7	29.4	20.6

- Estimated costs for a power plant newly built in 2013.
- Under the assumption that the capacity factors for nuclear and thermal power plants are both 80% and the duration of nuclear plant operation is 40 years.

Note 1: Figures for some cost items should not be simply added, to which attention must be paid.

Note 2: Figures in black in the graph correspond to the column totals inside the black box and those in red (in parentheses) to the column totals inside the red box.

Costs and Benefits Now Associated with the Suspension of Nuclear Power Plant Operation



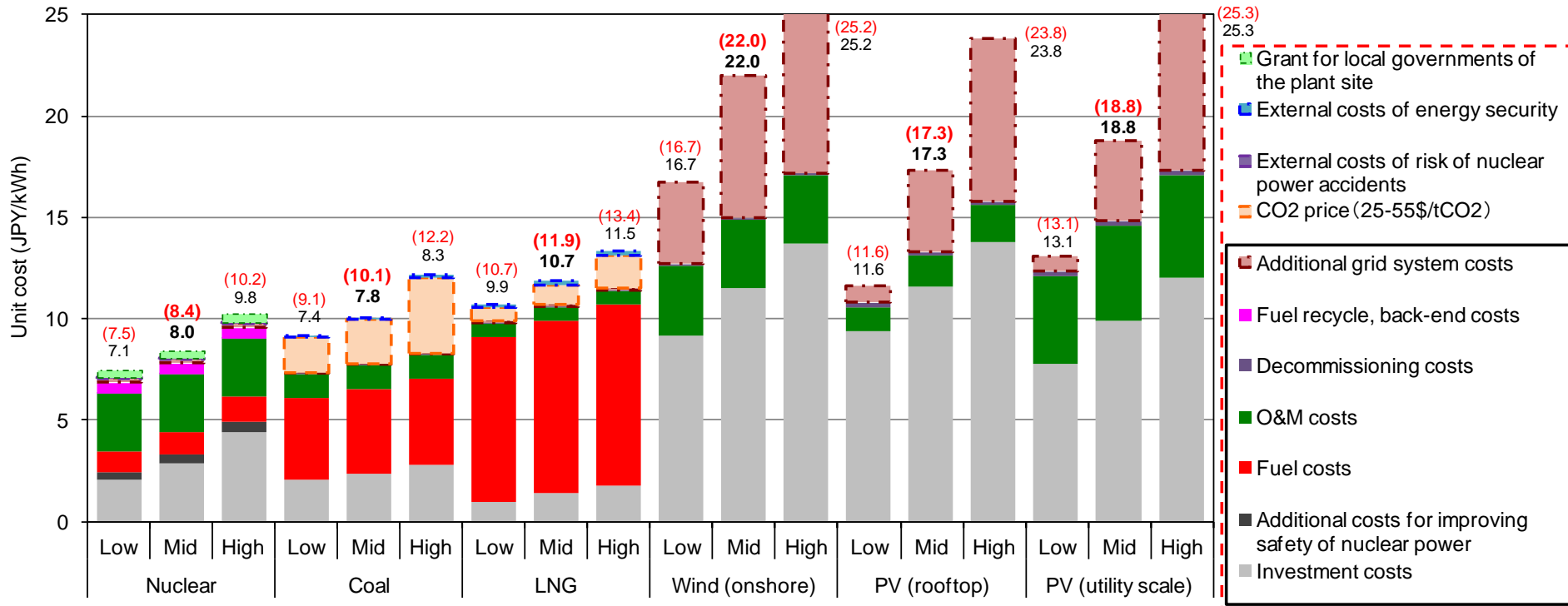
Significant additional costs are now incurred as follows:

Substitution by

- LNG: About ¥8/kWh
- Oil: About ¥16/kWh
- Wind power: About ¥16/kWh (¥21/kWh on FIT procurement price basis)
- Photovoltaic power: About ¥25 to 29/kWh (About ¥32 to 34/kWh on FIT procurement price basis)

- This analysis is based on the cost estimate on the previous slide.
- However, avoided investment costs (benefits) do not include the investment costs for nuclear power plant because this is an estimate of costs and benefits associated with the suspension of existing nuclear power generation.

Estimate of Power Generation Costs by Power Source for 2030



- Estimated costs for a plant newly built in 2030
- Under the assumption that the capacity factors for nuclear and thermal power plants are 60-85% and 80%, respectively, and the lifespan of a nuclear plant is 40 to 60 years.
- The external cost of CO2 is assumed to be \$33/tCO2 for the above medium values.

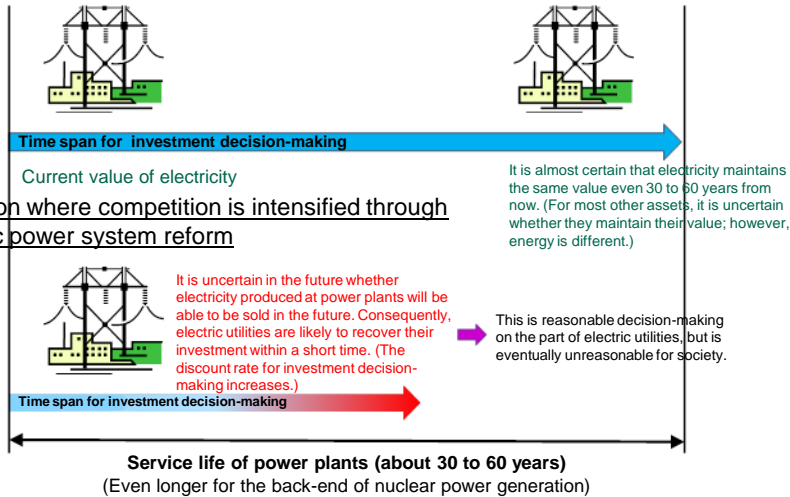
Note 1: Figures for some cost items may not be simply added, to which attention must be paid.

Note 2: Figures in black in the graph correspond to the column totals inside the black box and those in red (in parentheses) to the column totals inside the red box.

- In the future, the costs of photovoltaic power generation may probably be reduced, whereas additional costs of grid system are predicted to increase according to large installations of wind and photovoltaic power generation.

Investment Decision of Electric Utilities under a Competitive Environment

Situation under the comprehensive cost principle



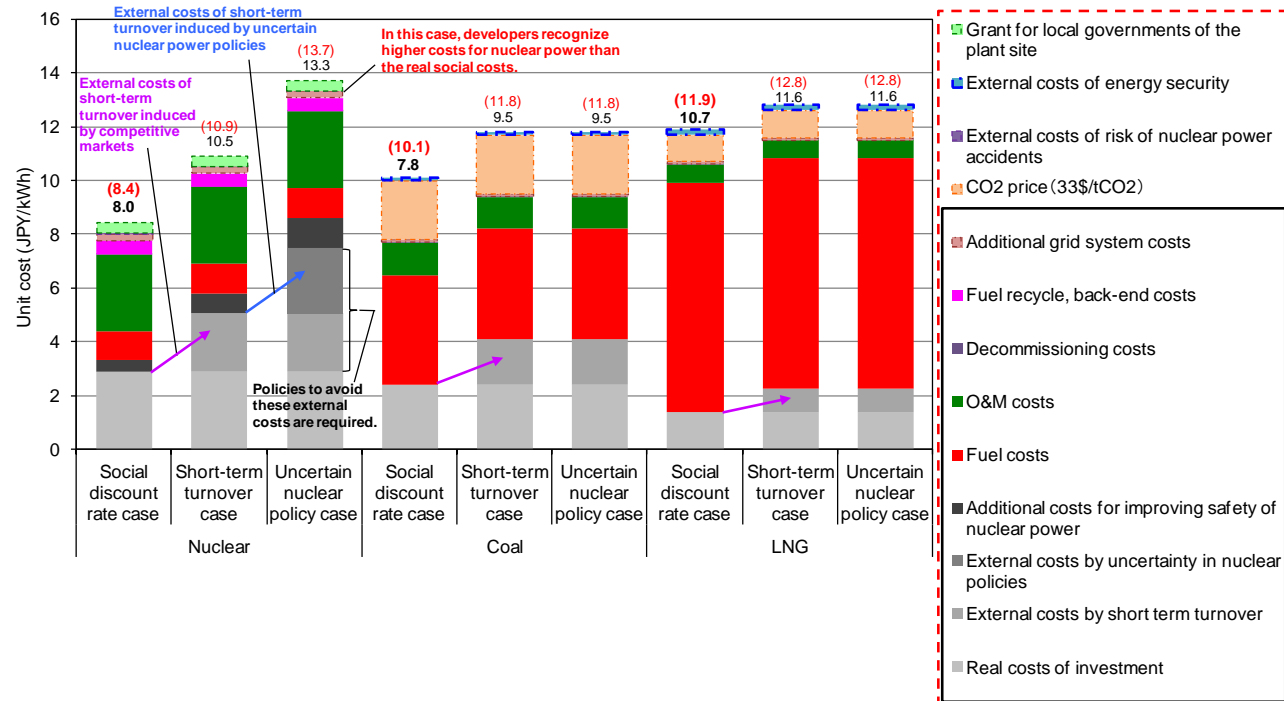
Situation where competition is intensified through electric power system reform

Under the following assumptions:

“Social discount rate case”: Discount rate of 5%

“Short-term turnover case: Discount rate of 10%

“Uncertain nuclear policy case”: Discount rate of 15%



As competition is intensified under the electric power system reform process, social costs deviate from the costs recognized by electric utilities. Policy measures must be taken to correct such deviation.

Major Findings from the Analysis (1/2)

- ◆ **Fossil fuel prices are increasing and the difference between nuclear and thermal power generation costs has further increased from that estimated by the Cost Verification Committee in 2011. Despite the trend of increasing additional costs for improving the safety of nuclear power generation, nuclear power is certainly a relatively low-cost power source. With global warming damage costs (carbon prices) taken into consideration, its cost advantage is significant against coal power generation. These findings must be acknowledged regardless of personal preferences as the above analysis being objective, based on likely assumption.**
- ◆ **The procurement costs to date under the Feed-in Tariff Scheme for Renewable Energy obviously has far exceeded a “modest profit” level. Securing such significant profits gives benefits only to a limited number of renewable energy power producers while placing an excessive burden on many electricity users. Since there is also a concern that this practice might reduce the industrial competitiveness of Japan over a long period of time and also increase the burden on the economically weak groups, it must be immediately reviewed.**
- ◆ **Toward 2030, photovoltaic power generation costs are expected to be reduced. However, corresponding to the increase in the amount of electricity generated by photovoltaic power, system stabilization costs are predicted to increase and additional costs to substitute wind and/or photovoltaic power for nuclear power may probably be up to about ¥10/kWh, which will cause a significant burden.**

Major Findings from the Analysis (2/2)

- ◆ **Even if global warming damage costs (carbon prices) of \$33/tCO₂ in 2030 are taken into consideration, coal power generation costs are significantly advantageous compared to the costs of other power sources (excluding nuclear power). To address global warming (CO₂ emissions reductions) in the longer term, coal power generation should not be significantly expanded. However, with its low costs taken into consideration, a certain level of expansion of coal power generation must be kept in mind as an option under circumstances where it is difficult to expand nuclear power generation.**
- ◆ **Under a situation where competition is intensified by electric power system reform or where future energy and nuclear power policies remain as unclear as they are now, electric utilities eventually take their own way to evaluate costs, including the cost of the risk in the investment environment, which costs may deviate from the real costs in society. Since this may cause a deviation from the social benefits of the electric power generation system, additional policies are required to close the gap between the desired long-term social benefits and the problems which may potentially be produced by the short-term profit-oriented behavior of electric utilities in an increasingly intensified competitive environment, while removing uncertainty in energy and nuclear power policies.**